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12-14 June 2007, at US Naval Academy, Annapolis, MD

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_____ _____

(Please use the same title listed on MORSS Form 712 A/B. If the title was changed please list the revised title below.) Revised title:

__ **MATREX: A Unifying Modeling and Simulation Architecture for Live-Virtual-Constructive Applications**_____

Presented in: WG(s) #__29, 31_____, Backup CG__E_Special Session _____,

Demonstration, _____, Tutorial, _____ or Focus Session # _____

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U.S. Army Research, Development and Engineering Command

TECHNOLOGY DRIVEN. *WARFIGHTER FOCUSED.*

MATREX: A Unifying Modeling and Simulation Architecture for Live-Virtual-Constructive Applications

Tom Hurt / 703.806.0995 / tom.hurt@us.army.mil

23 May 2007

MATREX v2.0 Environment
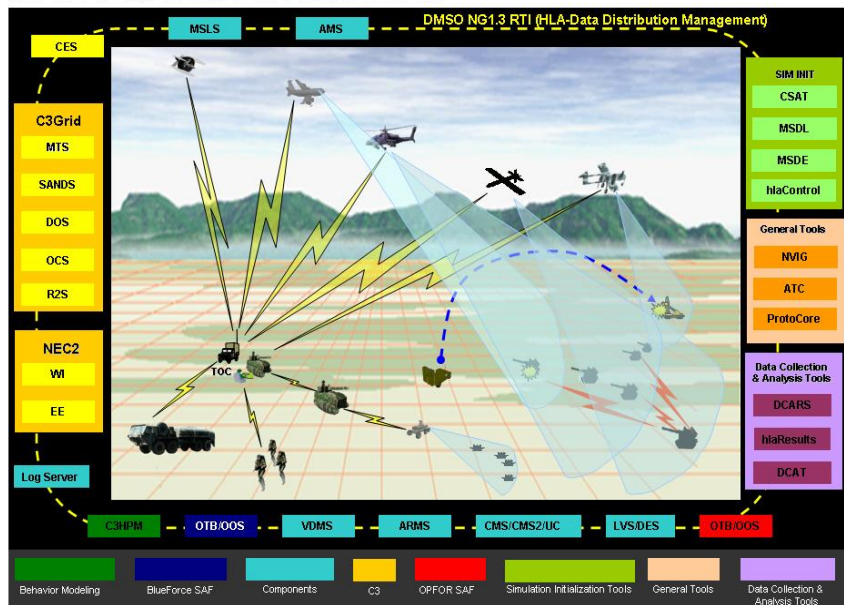
Primary Partners and Customers:
- RDECOM HQ, RDECs, and Labs
- PM FCS (BCT) MSO / FCS LSI
- TRADOC (BLCSE)
- 3CE (Cross Command Collaboration Effort) including TRADOC, ATEC, FCS LSI, RDECOM
- Other Army PMs and PEOs

Purpose:
To develop a composable M&S environment wherein a collection of multi-fidelity models, simulations and tools can be integrated into an established architecture for conducting analysis, experimentation and technology trade-offs for RDECOM and others.

Benefits:
- Enables reconfiguration and reuse of components for:
  - Engineering model development and evaluation
  - Technology tradeoffs
  - Capabilities assessments
  - Concept development
  - Experimentation
  - Testing

- Mutually and collectively leverages the world-class expertise of all RDECOM M&S laboratories for the benefit of the Army
- Supports decision making over entire acquisition cycle

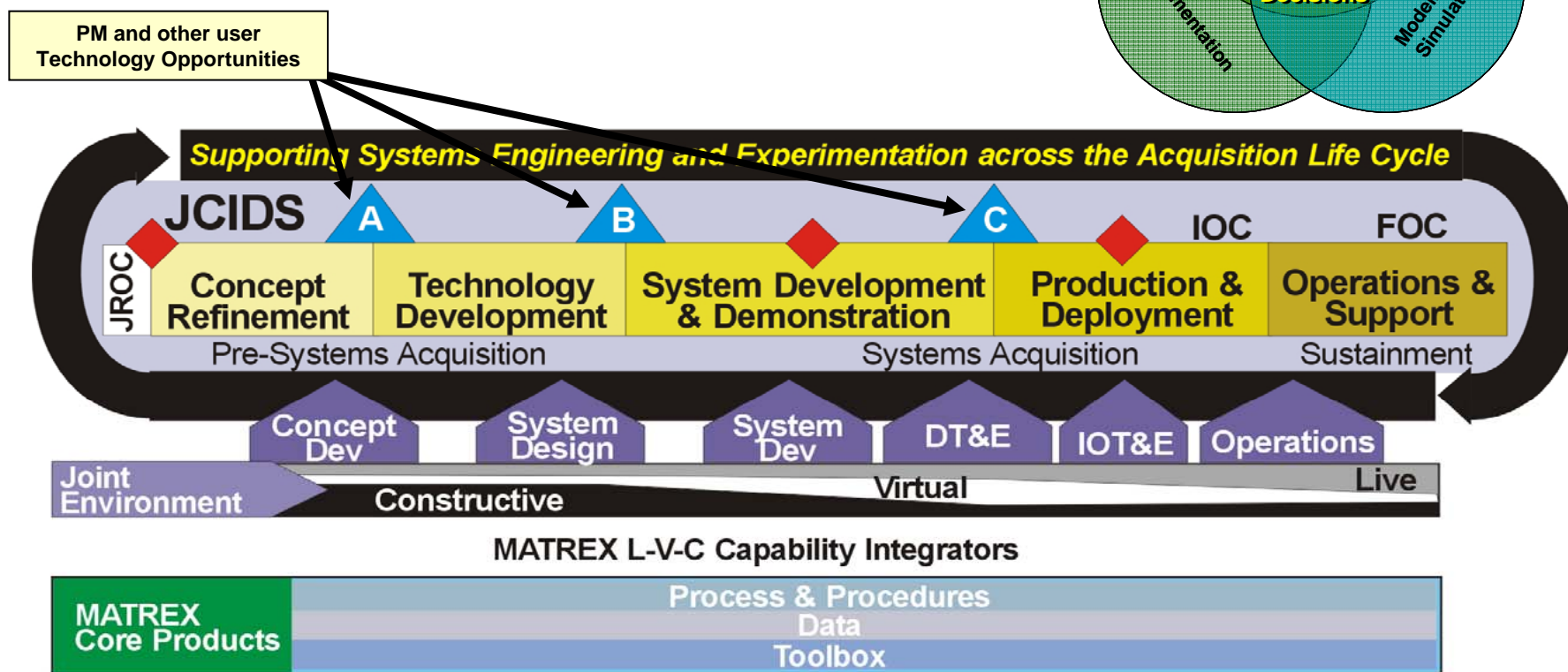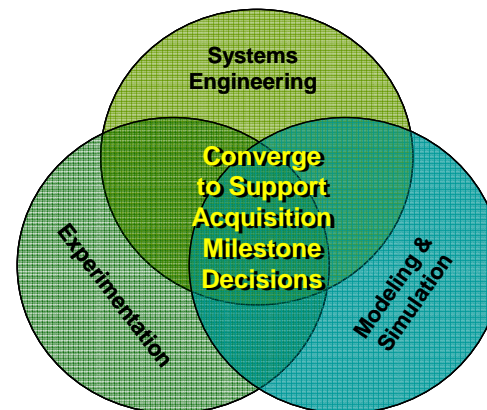**Critical M&S capabilities necessary to support Network Centric Warfare representation and analysis**

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Enable cross-commodity M&S tools, capabilities, processes and people to support technology development, systems integration and product development across the life cycle.

Systems Engineering

Converge to Support Acquisition Milestone Decisions

Experimentation

Modeling & Simulation

PM and other user Technology Opportunities

Supporting Systems Engineering and Experimentation across the Acquisition Life Cycle

JCIDS

A   B   C   IOC   FOC

JROC

| Concept Refinement | Technology Development | System Development & Demonstration | Production & Deployment | Operations & Support |

Pre-Systems Acquisition   Systems Acquisition   Sustainment

Concept Dev   System Design   System Dev   DT&E   IOT&E   Operations

Joint Environment   Constructive   Virtual   Live

MATREX L-V-C Capability Integrators

MATREX Core Products

Process & Procedures
Data
Toolbox

Reduce expense of "Live" activities

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3CE Mission and Intent

Mission (Vision): *Develop a cross command Army M&S and data environment for design, development, integration, and testing of capabilities, systems, and prototypes.*

JCIDS		A	B		C	IOC	FOC
	Concept Refinement **Concept Decision**	Technology Development	System Development & Demonstration **Critical Design Review**		Production & Deployment LRIP/IOT&E **FRP Decision Review**		Operations & Support
	JROC	Pre-Systems Acquisition		Systems Acquisition			Sustainment

Concept Dev → System Design → System Dev → DT&E → IOT&E → Operations

Constructive · **Virtual** · **Live**

3CE / Core Products

Process & Procedures | Data | **Toolbox**

TRADOC | ATEC | PM FCS (BCT) | RDECOM

Intent:

Purpose: *Identify, develop, and maintain a core set of M&S tools, data, and business processes that provide interoperable connectivity which links the participating organizations, to include providing a common 3CE environment and expertise for the Army to leverage.*

End State: *A 3CE environment that meets the common requirements of all three commands and PM FCS BCT to conduct distributed DOTMLPF development.*

Relevant Today and Into the Future

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RDECOM

MATREX

RDECOM SMEs Across Army Technology Commodities

(MATREX — Modeling Architecture for Technology, Research and Experimentation; ECBC, AMRDEC, AMSAA, CERDEC, TARDEC, ARL, ARDEC, NSRDEC, STTC)

Distributed to . . . .

TRADOC	UofA Maneuver Battle Lab Air Maneuver Battle Lab Depth & Simultaneous Attack BL Battle Command Battle Lab TRAC Leavenworth TRAC-WSMR
ATEC	IRCC WSMAR HQ USAOTC USAOTC-IEW Electronic PG, Fort Lewis APG Test Center WDTC, Dugway PG RTTC RTTC-RSA
PM	PEO-STRI NLOS-LS PM FCS (BCT) – FCS LSI
Other Services	LMC-Orlando (USN) Navy Research Lab Naval Air Warfare Center JTAGGS (USAF)

SMEs Across Acquisition Life Cycle

Partners & Collaboration

ATEC (OTC/DTC)
- Test Event Support
- Live Interface
- Sim to C2
- Sim Research

TRADOC
- Analytical Requirements
- BLCSE Conversion to HLA
- FFID Planning
- Sim Infrastructure & Tools

3CE
- Core Planning
- Sim Systems Engineering
- Federation/FOM/Tools
- FCS Spin Out 1
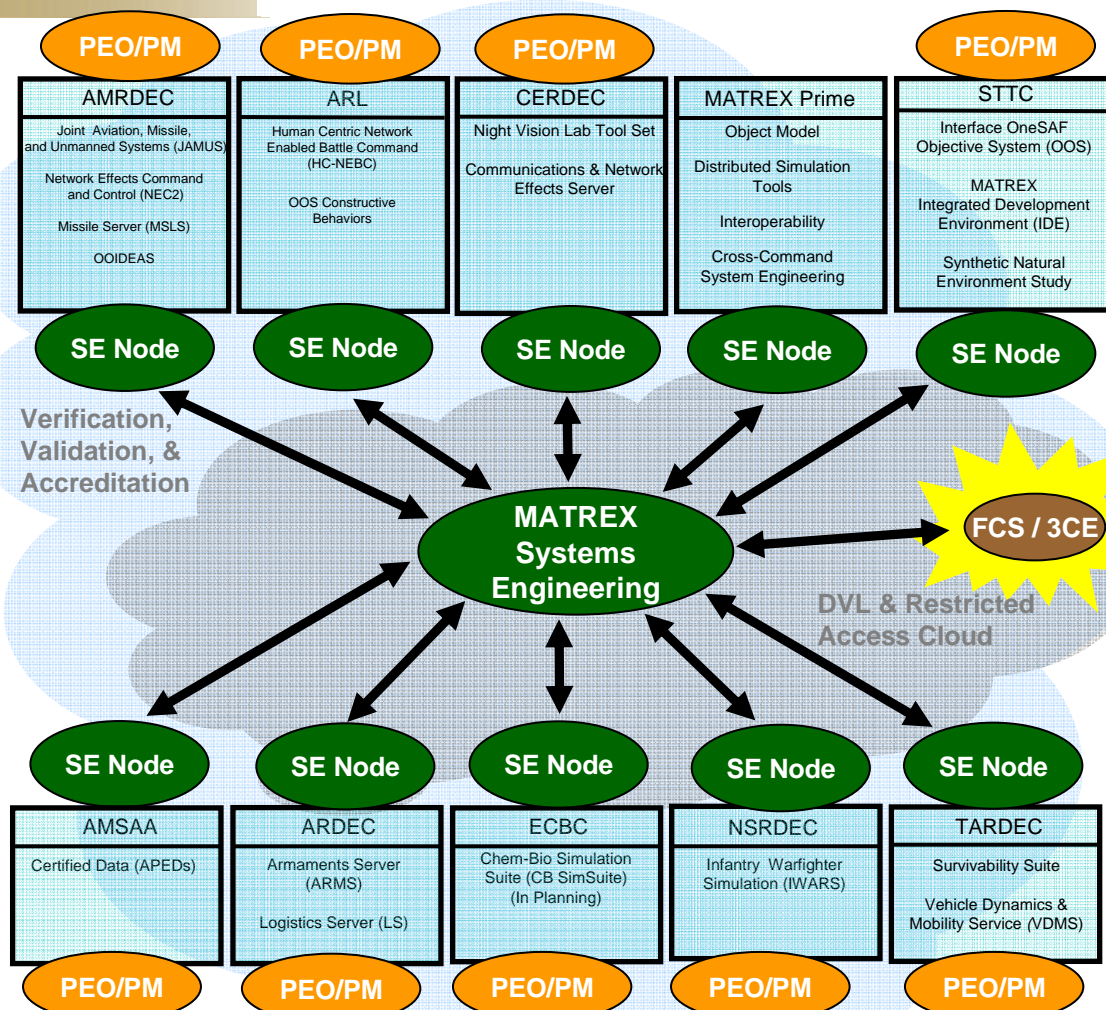- Sim Infrastructure & Tools

FCS LSI
- FOM
- FCS Simulation Environment (FSE)
  Collaboration & Development
- GFX Delivery, Training & Support

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Systems Engineering for MATREX and RDECOM - Operational View

PEO/PM

AMRDEC
Joint Aviation, Missile, and Unmanned Systems (JAMUS)

Network Effects Command and Control (NEC2)

Missile Server (MSLS)

OOIDEAS

PEO/PM

ARL
Human Centric Network Enabled Battle Command (HC-NEBC)

OOS Constructive Behaviors

PEO/PM

CERDEC
Night Vision Lab Tool Set

Communications & Network Effects Server

MATREX Prime
Object Model

Distributed Simulation Tools

Interoperability

Cross-Command System Engineering

PEO/PM

STTC
Interface OneSAF Objective System (OOS)

MATREX Integrated Development Environment (IDE)

Synthetic Natural Environment Study

SE Node · **SE Node** · **SE Node** · **SE Node** · **SE Node**

Verification, Validation, & Accreditation

MATREX Systems Engineering

FCS / 3CE

DVL & Restricted Access Cloud

SE Node · **SE Node** · **SE Node** · **SE Node** · **SE Node**

AMSAA
Certified Data (APEDs)

ARDEC
Armaments Server (ARMS)

Logistics Server (LS)

ECBC
Chem-Bio Simulation Suite (CB SimSuite) (In Planning)

NSRDEC
Infantry Warfighter Simulation (IWARS)

TARDEC
Survivability Suite

Vehicle Dynamics & Mobility Service (VDMS)

PEO/PM · **PEO/PM** · **PEO/PM** · **PEO/PM** · **PEO/PM**

Integrated M&S System of Systems Engineering Capability for RDECOM via MATREX:

- **Supporting PEOs and PMs with a coordinated RDECOM approach**
- **Common integrating SoS Architecture synchronized across RDECOM**
- **Standing up SE Nodes for M&S across RDECOM:**
  – Integrated M&S Culture
  – Common Engineering Tools
  – Common Requirements Database, terminology, and processes
  – Distributed / Collaborative enabling services:
    • Web Collaboration (STEM, IDE, AKO)
    • DVL Services
- **Maximize interoperability, flexibility and adaptation of RDECOM M&S capabilities to the Acquisition Communities needs.**
- **Common OM and Core Capabilities/Tools**

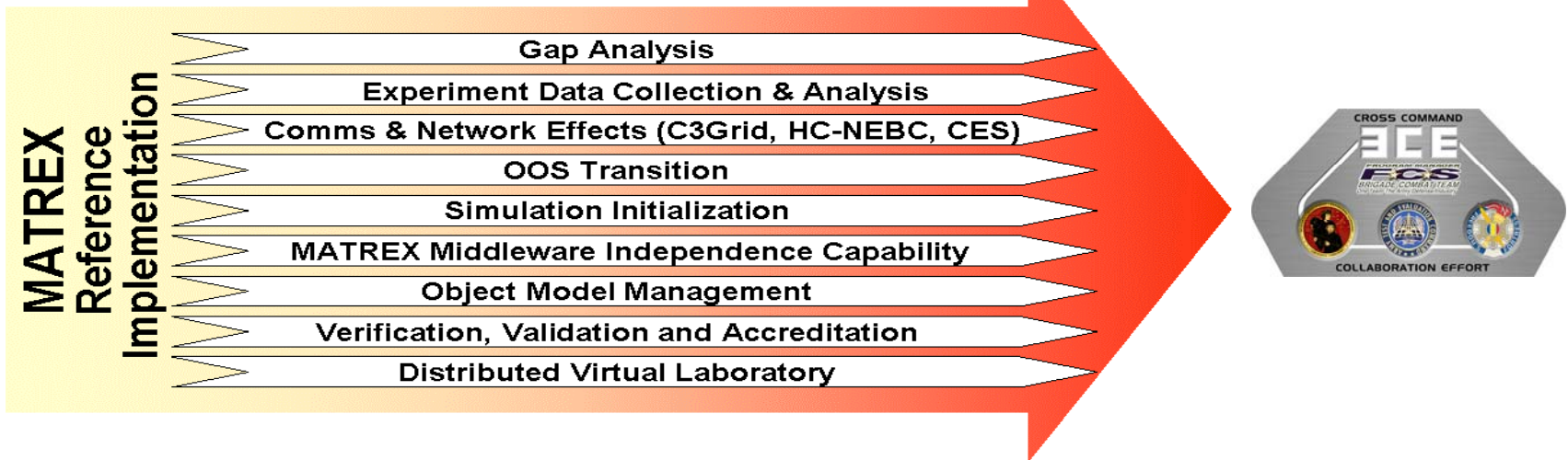## MATREX reduces Technical and Cost Risks for the FCS and other programs through external coordination of RDECOM M&S

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23 May 2007

Networked Fires

MATREX Reference Implementation

- Gap Analysis
- Experiment Data Collection & Analysis
- Comms & Network Effects (C3Grid, HC-NEBC, CES)
- OOS Transition
- Simulation Initialization
- MATREX Middleware Independence Capability
- Object Model Management
- Verification, Validation and Accreditation
- Distributed Virtual Laboratory

CROSS COMMAND
3CE
FCS
BRIGADE COMBAT TEAM
COLLABORATION EFFORT

- **Leverage 3CE requirements development (TRADOC Integrated Process 3 "Networked Fires" (IP-03), LSI mission threads, ATEC OTC, TRADOC BLCSE, …) to drive capability, integrated process, and methodology development for 3CE, ATEC OTC, TRADOC BLCSE)**

- **Develop MATREX overarching M&S Framework consisting of:**

  - **OneSAF Objective System (OOS) integration into M&S architecture**
  - **Integrated capabilities and baseline that supports analysis of Future Force Network Centric Warfare (NCW)**
  - **MATREX Middleware Independence Capability (MMIC) which enables Live-Virtual-Constructive interoperability**
  - **Work toward a common means of simulation initialization and data collection and analysis tools and processes**

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MMIC Problem Space

Current Architecture Path (Too Costly)

FY 02

IDEAS   HLA   DIS

Model A   Model B   Model X   Model Y   CDAS   CMS2/UC   MC2

AMS   MSLS   C3 Grid   LVS $ ARMS $ VDMS $

$ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $ $
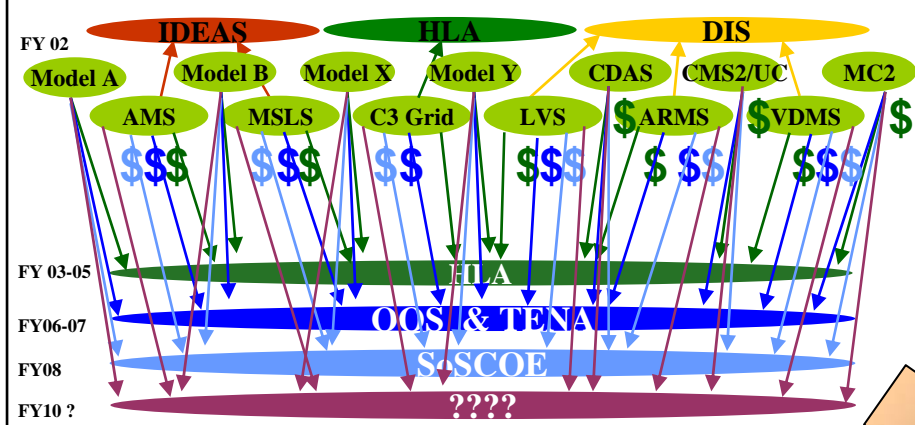
FY 03-05   HLA

FY06-07   OOS & TENA

FY08   SoSCOE

FY10 ?   ????

Problem:
- The Army spends millions of dollars per year migrating Models and Simulations between various middleware architectures and building gateways
- The average rate of change migrating from one middleware layer to the next is increasing

Meta-Modeling & Code Generation Concept

Model A   Model B   Model X   Model Y   CDAS   CMS2/UC   MC2

AMS   MSLS   C3 Grid   LVS   ARMS   VDMS $

$ $ $ $ $

FY03 - 05   HLA

Migrate onto Meta Model

$

Code Generation Interface   Code Generation Interface   Code Generation Interface   Code Generation Interface

FY06-07   HLA   OOS & TENA

FY08   SoSCOE

FY10 ?   ????

Technical Milestones

Block 1
- MATREX Tools v1.3
  - FCS FOM Changes for IV-1
- MATREX Tools v1.4
  - Merged BLCSE FOM
  - Sync Point Support
  - RTI 1516 Plug-in
- MATREX Tools v1.5
  - Dynamic DDM Support
  - Time Management Support
  - TENA MW Plug-in

Block 2
- Construct TENA & MATREX Object Model
- Build TENA execution using TENA tools
- Prototype the OOS Plug-in
- Build initial Protocore Object Model

Block 3
- Build initial Protocore Object Model Translator
- Complete OOS Plug-in
- Implement Save and Restore

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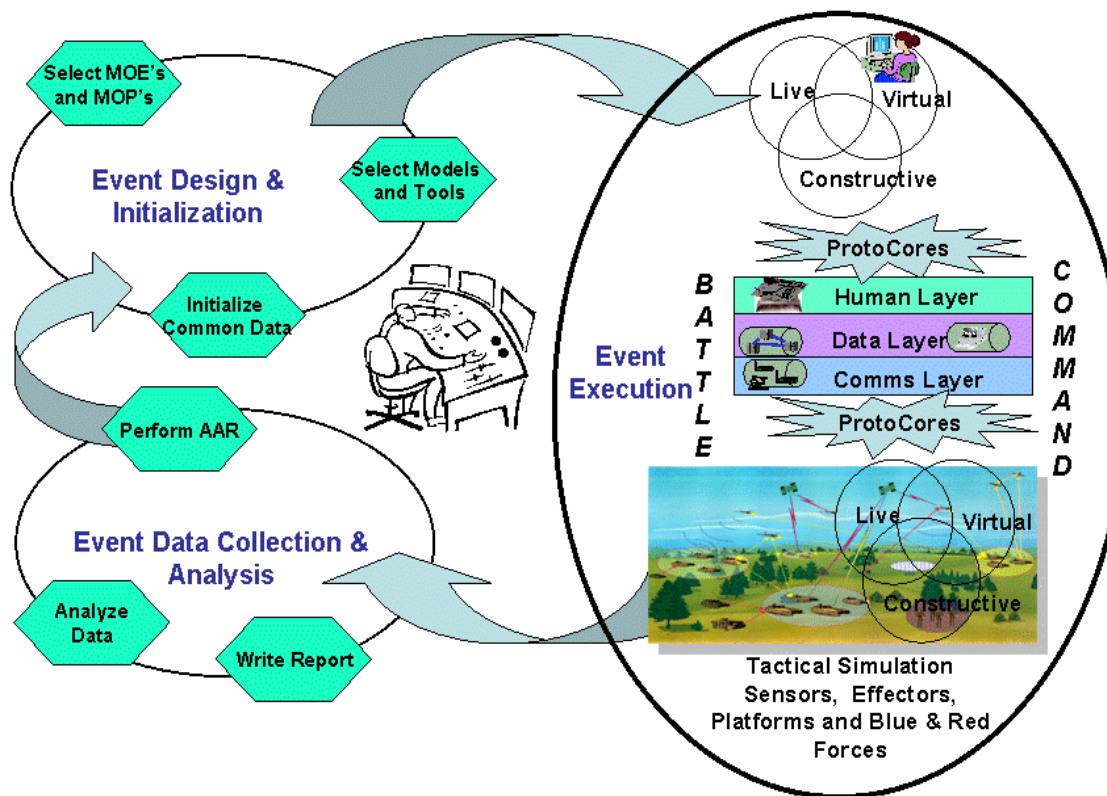Tom Hurt / 703.806.0995 / tom.hurt@us.army.mil

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Event . . . .
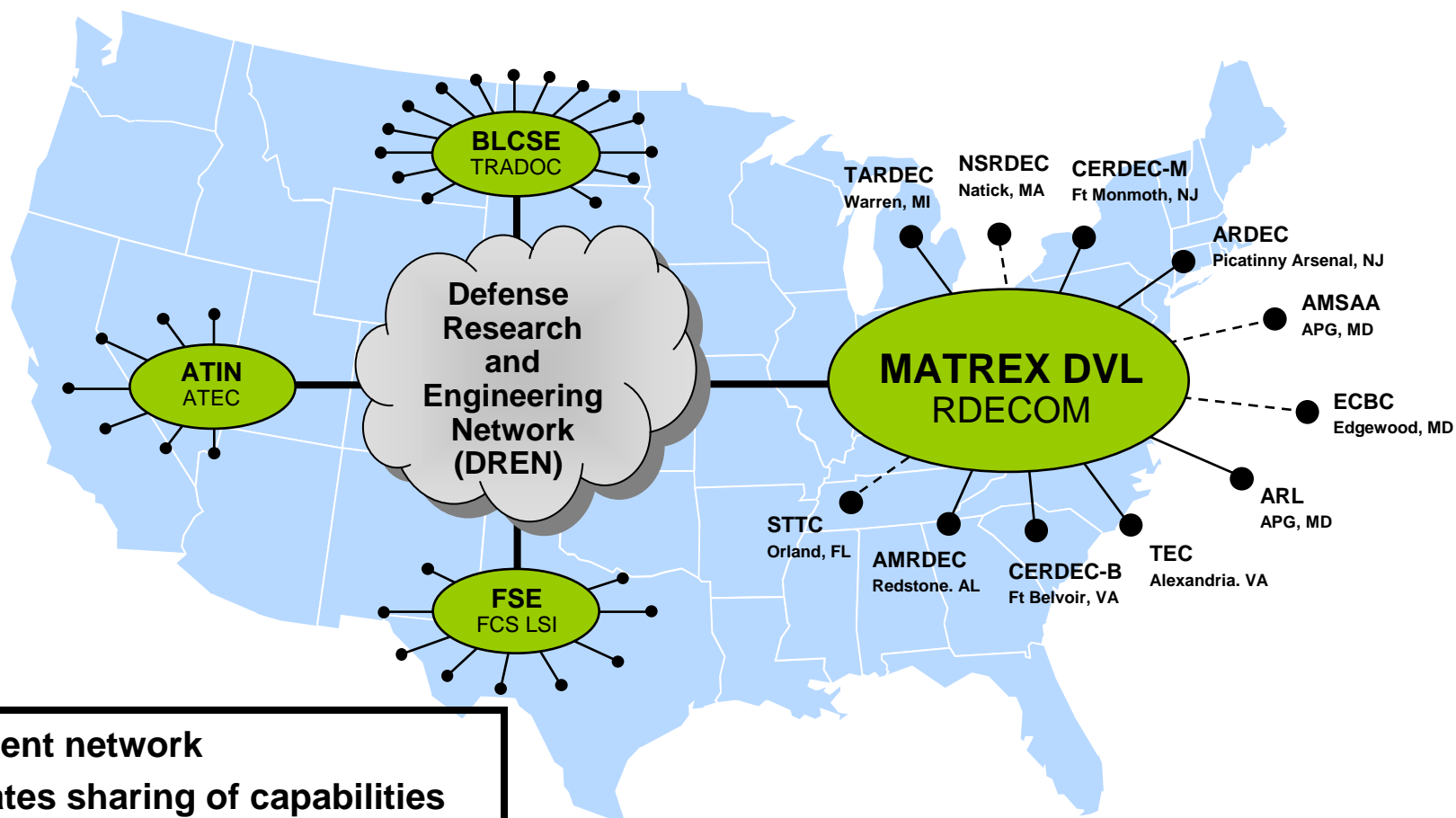
- Design & Initialization
- Execution
- Data Collection & Analysis

Advantages

- Process-oriented
- Composable federation
- Multi-resolution
- BCT and smaller

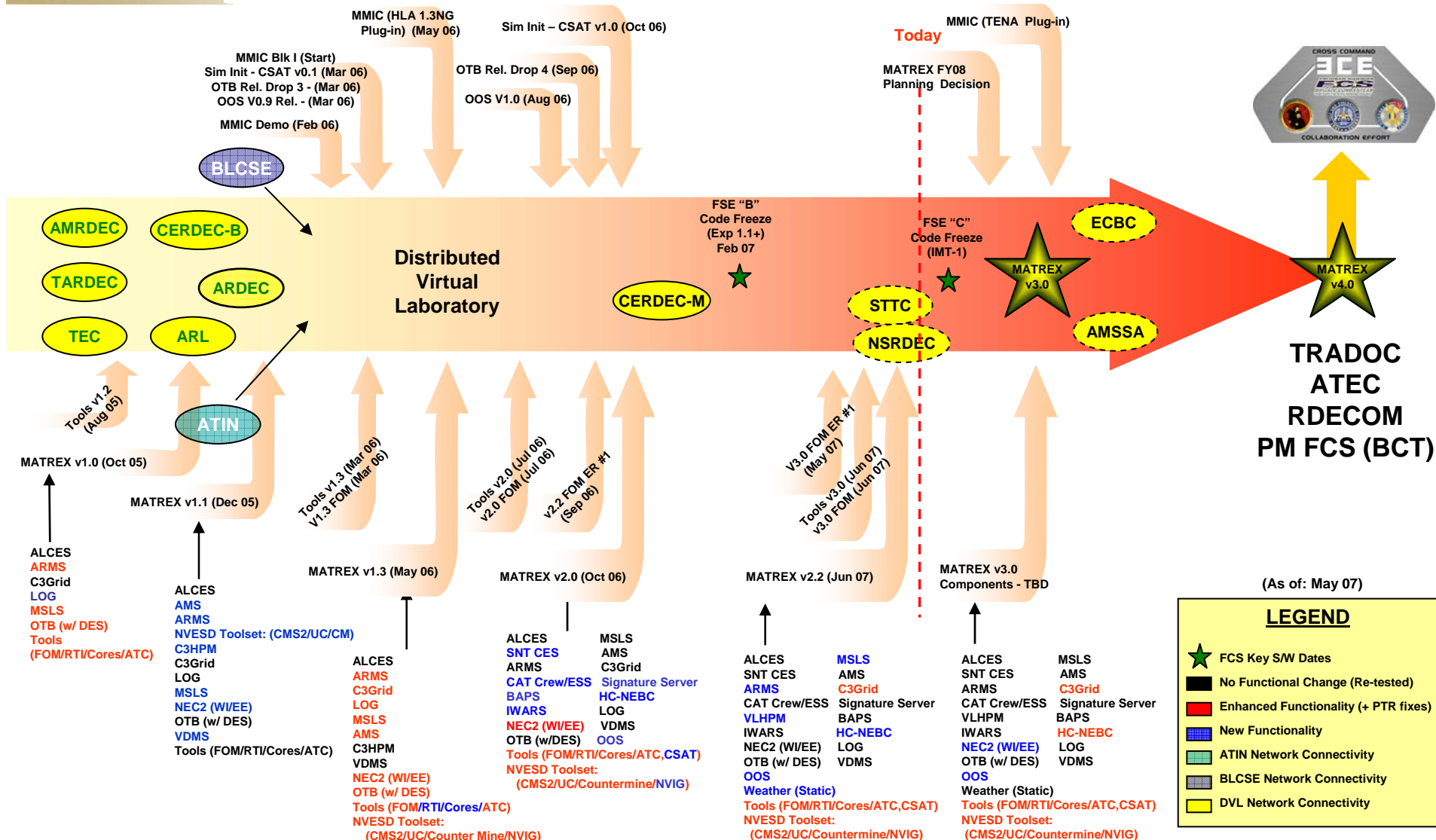**TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

- **Persistent network**
- **Facilitates sharing of capabilities**
- **Collaborative use of RDECOM and Army resources**
- **Work requirements as integrated systems of systems**

To Be Connected - - - - - -

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MATREX DVL and Reference Implementation Release Schedule

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23 May 2007

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- MATREX is helping to advance simulation technology, infrastructure, and processes to enable better informed decision making.

- MATREX (RDECOM) is working with TRADOC, ATEC, and the PM-FCS(BCT)/FCS LSI to build an Army solution for M&S experimentation applicable across the acquisition life cycle.

- MATREX is providing many of the tools and methodologies to help reduce technical, cost and schedule risk for PMs.

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- 3CE – Cross-Command Collaborative Effort
- ACS – Aerial Common Sensor
- AKO – Army Knowledge On-Line
- ALCES - Aggregate Level Communications Effects Service
- AMS – Aviation Mobility Service
- AMSWG – (OSD) Acquisition Modeling & Simulation Working Group
- ARMS – Armaments Service
- ATC – Automated Test Capability
- ATEC – Army Test and Evaluation Command
- ATIN – ATEC Test Integration Network
- AUTL – Army Universal Task List
- BCT – Brigade Combat Team
- BLCSE – Battle Lab Collaborative Simulation Environment
- C3HPM – Command, Control, & Communications Human Performance Model
- C3GRID – Command & Control, Computer GRID
- CES – Communications Effects Server
- CMS – Countermine Server
- CMS2 – Comprehensive Munitions & Sensor Server
- CSAT – C4ISR Static Analysis Tool
- C4ISR – Command & Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
- DCARS – Data Collection, Analysis & Reporting System
- DCA – Data Collection & Analysis
- DCAT – Data Collection & Analysis Tool
- DES – Damage Effects Server
- DOTMLPF – Doctrine, Organization, Training, Materiel, Leadership, Personnel & Facilities
- DOS – Dynamic Organization Service
- DTC – Developmental Test Command
- DTE – Distributed Test Event
- DT&E – Developmental Test and Evaluation
- DVL – Distributed Virtual Laboratory
- EE – Effects Engine
- FCS – Future Combat Systems
- FOC – Full Operational Capability
- FOM – Federation Object Model

- FRP – Full Rate Production
- FSE – FCS Simulation Environment
- HLA - RTI – High Level Architecture – Run Time Interface
- HC-NEBC – Human Centric – Network Enabled Battle Command
- HPM – Human Performance Model
- IDE – Integrated Development Environment
- IOC – Initial Operational Capability
- IOT&E – Initial Operational Test and Evaluation
- IER – Information Exchange Requirement
- IP03 – Integrated Process 03, Networked Fires
- IPT – Integrated Process Team
- IWARS/DI – Infantry Warrior Simulation/Dismounted Infantry
- JCAS – Joint Close Air Support
- JCIDS – Joint Combat Integrated Defense System
- JROC – Joint Requirements Oversight Council
- JSBE – Joint Service Battlespace Environment
- KPP – Key Performance Parameters
- LSI – Lead Systems Integrator (FCS)
- LVC – Live Virtual Constructive
- LVCI - Live Virtual Constructive Interoperability
- LVS – Lethality/Vulnerability Service
- MATREX – Modeling Architecture for Technology, Research, & EXperimentation
- MC2 – Mobile Command & Control
- MDA – Model Driven Architecture
- MMIC – MATREX Middleware Independence Capability
- MOE – Measures of Effectiveness
- MOP – Measures of Performance
- M&S – Modeling and Simulation
- MSDE – Military Scenario Development Environment
- MSDL – Military Scenario Definition Language
- MSLS – Missile Service
- MSO – PM FCS (BCT) Modeling & Simulation Office

- MTS – Message Transceiver Service NCW – Network Centric Warfare
- NEC2 – Networked Effects Command & Control
- NVIG – Night Vision Image Generator
- OCS – Organic Communications Service
- OneSAF – One Semi-Automated Forces
- OOS – OneSAF Objective System
- OTB – OneSAF Testbed Baseline
- OTC – Operational Test Command
- PEO – Program Executive Office
- PM – Product, or Program or Project Manager
- R2S – Relative Roles Server
- RDECOM – Research, Development, & Engineering Command
- RDEC – Research, Development & Engineering Center
- S3E – Systems Engineering, Experimentation, and Enterprise
- SANDS – Situational Awareness Normalization & Dissemination Service
- SE – Systems Engineering
- Sim Init – Simulation Initialization
- SNE – Synthetic Natural Environment
- SoS – System of System
- SoSE – System of System Engineering
- SOSCOE – System of Systems Common Operating Environment
- STEM – Science and Technology Enterprise Management
- S&T – Science and Technology
- TENA – Test & Training Enabling Architecture
- TIE – Technical Integration Event
- TRADOC – Training & Doctrine Command
- UAV – Unmanned Aerial Vehicle
- UC – Universal Controller
- UJTL – Universal Joint Task List
- USAF – United States Air Force
- USMC – United States Marine Corps
- VDMS – Vehicle Dynamics & Mobility Service
- V&V – Verification and Validation
- VV&A – Verification, Validation & Accreditation
- WECM – Warfighter Electronic Collection and Mapping
- WI – Warfighter Interface

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